PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB2004/004397	15.10.2004	31.10.2003

International Patent Classification (IPC) or both national classification and IPC
C07C29/149, C07C29/17, C07C31/20, C07D315/00, C07D307/08, B01J31/24

Applicant
DAVY PROCESS TECHNOLOGY LIMITED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ in written format

   ☐ in computer readable form

   c. time of filing/furnishing:

   ☐ contained in the international application as filed.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/GB2004/004397

Box No. II Priority

1. ☒ The following document has not been furnished:

   ☒ copy of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(a)).

   ☐ translation of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(b)).

   Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. ☐ It has not been possible to consider the validity of the priority claim because a copy of the priority document was not available to the ISA at the time that the search was conducted (Rule 17.1). This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

4. Additional observations, if necessary:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V.

1. The following documents are referred to in this communication :

D1 : US 5 478 952 A (SCHWARTZ JO-ANN T) 26 December 1995
D2 : US 5 047 561 A (ISOGAI SHINJI ET AL) 10 September 1991
D3 : US 4 301 077 A (PESA FREDERICK A ET AL) 17 November 1981

2. Novelty

2.1 Document D1 discloses (cf. the international search report) a process for the production of tetrahydrofuran and/or 1,4-butanediol by hydrogenation of dicarboxylic acids using a heterogeneous ruthenium catalyst in the presence water as solvent, wherein hydrogen is used to strip the reaction product from the reactor. The relative amount of hydrogen used to strip 1 mole of product from the reactor is not disclosed.

The subject-matter of the present application differs from this known process in that a homogeneous metal phosphine catalyst is used.

2.2 Document D2 discloses (cf. the international search report) a process for the production of lactones by hydrogenation of dicarboxylic acids using a homogeneous ruthenium phosphine catalyst in the presence of at most 1 wt.% of water.

The reaction condition according to claim 1, especially the use of 1 to 10 mole of hydrogen to strip 1 mole of product from the reactor are not disclosed.

2.3 Document D3 discloses (cf. the international search report) a process for the production of tetrahydrofuran and/or 1,4-butanediol by hydrogenation of dicarboxylic acids using a heterogeneous ruthenium catalyst in the presence of less than 25 wt. % of water.

The subject-matter of the present application differs from this known process in that a homogeneous metal phosphine catalyst is used and 1 to 10 mole of hydrogen are used to strip 1 mole of product from the reactor.

2.4 The subject-matter of independent claim 1 and dependent claims 2-20 is

therefore novel (Article 33(2) PCT).

3. Inventive Step

Document D1, pertaining to the production of tetrahydrofuran and/or 1,4-butanediol and the use of hydrogen as stripping agent, is considered to represent the most relevant state of the art.

The subject-matter of claim 1 differs in that a homogeneous metal phosphine catalyst is used and a relative amount of 1 to 10 moles of hydrogen is used to strip 1 mole of product from the reactor.

The problem to be solved by the present invention may therefore be regarded as provision of an alternative process for the hydrogenation of dicarboxylic acids and/or anhydrides thereof.

The solution proposed in claims 1-20 of the present application can be considered as involving an inventive step (Article 33(3) PCT) :

Document D2 teaches the use of homogeneous ruthenium phosphine catalysts in the presence of at most 1 wt. % of water (preferably less). In example 1, an excess of about 45 molar equivalents of hydrogen is used in the presence of 0.27 wt. % of water.

A process according to claim 1, especially the use of only 1 to 10 moles of hydrogen to strip 1 mole of product, can therefore not be considered as obvious from the combination of D1 and D2.